

BASIS FOR THE AMENDMENT

The specification is amended to correct obvious typographical errors. Further, Applicants have informed the undersigned that the Examples present in the specification are "paper" examples, e.g. "prophetic". Accordingly, the undersigned has amended the specification to correct the tense in the each appropriate case.

The amendments to Claims 1 and 3 find basis in the Examples of the specification, as note Examples 1, 3 and 4.

The amendments to Claims 12 and 13 find basis at page 16, lines 23-26 of the specification.

Added Claims 14 and 15 find basis at page 6, lines 16-17 of the specification.

REMARKS

Favorable reconsideration of this application is requested.

Claims 1-15 are in the case.

Claims 1-13 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Leach. This rejection is traversed.

The invention relates to a urethane (meth)acrylate oligomer, a process for its production and a photo-curable composition. Particularly, it relates to a urethane (meth)acrylate oligomer which has a low viscosity and which gives a cured product excellent in flexibility and adhesive property and having a low surface stickiness, a process for its production and a photo-curable composition containing such an oligomer.

Specifically, the invention relates to a urethane (meth)acrylate oligomer obtained by reacting a polyol component (A) consisting of a polyoxypropylene polyol which has from 2 to 4 hydroxyl groups, a hydroxyl value V_{OH} (mgKOH/g) of from 5 to 115 and a total degree of

unsaturation V_{US} (meq/g) satisfying the formula 1, with a polyisocyanate compound (B) and a hydroxylated (meth)acrylate compound (C):

$$V_{US} \leq (0.45/V_{OH}) + 0.02 \quad \text{Formula 1}$$

A feature distinguishing the claimed invention over Leach is that by using a specific polyol (A), i.e. a polyoxypropylene polyol, an oligomer of low viscosity is obtained. By using such oligomer in the reaction with a polyisocyanate compound (B) and a hydroxylated (meth)acrylate compound (C), a photo-curable composition is obtained which is flexible and excellent in mechanical properties, when cured resulting in a product having little surface tackiness.

If, on the other hand, polyol (A) has an oxyethylene group, as in the preferred embodiments and examples of Leach, the viscosity tends to be high, even though mechanical properties are improved in some cases. This is evident from a comparison between the use of polyol (A) (Example 1) and polyol (B) (Example 2) of the specification. Note Table 2 at page 17 of the specification, reproduced below.

Table 2

Example	Viscosity	Surface tackiness	Mechanical properties	
			Tensile strength	Break elongation
1	5400	○	55	370
2	5900	○-◎	68	420
3	8200	△-○	43	560
4	5600	◎	74	320
5	4800	×	22	690

6	28000	◎	97	210
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Thus, as is evident from the results of the examples in the case, polyol (A) and polyol (B) being different, although having the same number of hydroxyl groups and the same hydroxyl value, the viscosities of the resulting oligomers are different due to the presence or absence of an oxyethylene group. Thus, the oligomer produced by using polyol (B) has a viscosity higher than the viscosity of the oligomer obtained by using polyol (A). Such is manifestly unobvious and could not have been foreseen.

Accordingly, withdrawal of the rejection of the claims under 35 U.S.C. § 102 is requested.

With regard to the rejection of Claims 12 and 13 under the second paragraph of 35 U.S.C. § 112, they have been amended in a manner believed to obviate this rejection, consistent with the disclosure.

Should any further amendments to the claims be considered necessary by the Examiner, she is requested to telephonically contact the undersigned so that mutually agreeable language may be arrived at.

Withdrawal of the rejection of the claims under 35 U.S.C. § 112, second paragraph, thus is requested.

It is submitted that this application is now in condition for allowance and which is solicited.

Respectfully submitted,

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IN THE SPECIFICATION

Page 2, please replace the paragraph beginning at line 15 to page 3, line 1 as follows:

With respect to such a urethane (meth)acrylate oligomer, molecular designing can easily be done by changing the starting material variously depending upon the [particularly] particular purpose of its use. Especially, it is easy to change the performance by the polyol to be used. When a low molecular weight polyol having a molecular weight of about a few hundreds, is used, a hard and brittle cured product will be obtained, and when a high molecular weight polyol having a molecular weight of from a thousand to a few thousands, is employed, a flexible and tough cured product will be obtained. As such a high molecular weight polyol, a polyoxyalkylene polyol, a polyester polyol, a polycaprolactone polyol or a polycarbonate polyol is, for example, employed.

Page 7, please replace the paragraph at lines 15-25 as follows:

Specifically, it may be a polyisocyanate such as tolylene diisocyanate, diphenylmethane diisocyanate, polymethylenepolyphenylene isocyanate (crude MDI), xylylene diisocyanate, isophorone diisocyanate or hexamethylene diisocyanate, or its prepolymer-modified product, [nulate-modified] isocyanurate modified product, urea-modified product or carbodiimide modified product. Among them, a diisocyanate having two

isocyanate groups in one molecule, is preferred. These polyisocyanate compounds may be used alone or in combination as a mixture of two or more of them.

Page 9, please replace the paragraph beginning at line 26 to page 10, line 5 as follows:

The reaction is preferably carried out at a temperature for a common urethane-modification reaction i.e. from 30 to 90°C. At the time of the reaction, a urethane-modification catalyst such as cobalt naphthenate, zinc naphthenate, lead 2-ethylhexanoate, dibutyltin dilaurate, tin [2-ethylhexanoate] 2-ethylhexanoate, triethylamine or 1,4-diazabicyclo[2.2.2]octane, may be used.

Page 11, please replace the paragraph beginning at line 23 to page 12, line 13 as follows:

Further, for the composition of the present invention, for the purpose of lowering the viscosity, the following ethylenically unsaturated group-containing compound may be used as a diluting agent. As such an ethylenically unsaturated group-containing compound, in addition to the above-mentioned hydroxylated (meth)acrylate compound (C) such as 2-hydroxyethyl(meth)acrylate, a (meth)acrylate compound containing no hydroxyl group, such as an alkyl (meth)acrylate such as methyl (meth)acrylate or ethyl (meth)acrylate, phenoxyethyl (meth)acrylate or [isobonyl] isobornyl (meth)acrylate, or a vinyl ether monomer such as hydroxybutyl vinyl ether, lauryl vinyl ether or 2-ethylhexyl vinyl ether, may be mentioned. The urethane (meth)acrylate oligomer of the present invention has a low viscosity by itself, and in many cases, such a diluting agent may not be required. It is preferred not to use such a diluting agent.

Page 13, please replace the paragraph beginning at line 2 as follows:

Polyol A, C: [Prepared] Is prepared by reacting propylene oxide to an initiator (a polyoxypropylene diol having a molecular weight of 700) using zinc hexacyanocobaltate-glyme complex as a catalyst, and then, deactivating the catalyst, followed by purification.

Page 13, please replace the paragraph beginning at line 7 as follows:

Polyol B: One is prepared by reacting propylene oxide to an initiator (a polyoxypropylene diol having a molecular weight of 700) using zinc hexacyanocobaltate-glyme complex as a catalyst, then reacting ethylene oxide, then deactivating the catalyst, followed by purification. The oxyethylene group-content is 20 wt%.

Page 13, please replace the paragraph beginning at line 13 as follows:

Polyol D: [Prepared] Is prepared by reacting propylene oxide to an initiator (a polyoxypropylene triol having a molecular weight of 1,000) using zinc hexacyanocobaltate-glyme complex as a catalyst, then deactivating the catalyst, followed by purification.

Page 13, please replace the paragraph beginning at line 18 as follows:

Polyol E: [Prepared] Is prepared by reacting propylene oxide to an initiator (a polyoxypropylene diol having a molecular weight of 700) zinc hexacyanocobaltate-t-butanol complex as a catalyst, then deactivating the catalyst, followed by purification.

Page 13, please replace the paragraph beginning at line 23 as follows:

Polyol F: [Prepared] Is prepared by reacting propylene oxide to an initiator (a polyoxypropylene diol having a molecular weight of 700) using potassium hydroxide as a

catalyst, followed by purification. In Table 1, the number of hydroxyl groups, the hydroxyl values V_{OH} (mgKOH/g), the total degrees of unsaturation V_{US} (meq/g) and values x ($x=(0.45/V_{OH})+0.02$) are shown.

Page 14, please replace the paragraph beginning at line 7 as follows:

To 100 parts by weight (hereinafter referred to simply as parts) (0.025 mol) of polyol A, 8.7 parts (0.05 mol) of tolylene diisocyanate (T-100, tradename, manufactured by Nippon Polyurethane Industry Co., Ltd.) [was] is added, followed by a reaction at 80°C for 4 hours in the presence of 0.01 part of dibutyltin dilaurate, to obtain a urethane prepolymer. To this urethane prepolymer, 0.05 part of dibutyltin dilaurate and 0.05 part of hydroquinone monomethyl ether [were] is added, and 6.38 parts (0.055 mol) of 2-hydroxyethyl acrylate [was] is dropwise added at 40°C. Thereafter, a reaction [was] is carried out at 60°C until absorption by an isocyanate group at a wavelength of 2,250 cm⁻¹ in the infrared absorption spectrum [was] is no longer observed, to obtain a urethane acrylate oligomer.

Page 15, please replace the paragraph beginning at line 3 as follows:

A urethane acrylate oligomer [was] is obtained in the same manner as in Example 1 except that polyol B [was] is used instead of polyol A.

Page 15, please replace the paragraph beginning at line 7 as follows:

A urethane acrylate oligomer [was] is obtained in the same manner as in Example 1 except that instead of 100 parts of polyol A, a mixture comprising 182 parts (0.0182 mol) of polyol C and 45 parts (0.0045 mol) of polyol D, [was] is used, to obtain a urethane acrylate oligomer.

Page 15, please replace the paragraph beginning at line 13 as follows:

A urethane acrylate oligomer [was] is obtained in the same manner as in Example 1 except that instead of polyol A, polyol E [was] is used.

Page 15, please replace the paragraph beginning at line 17 as follows:

A urethane acrylate oligomer [was] is obtained in the same manner as in Example 1 except that instead of polyol A, polyol F [was] is used.

Page 15, please replace the paragraph beginning at line 21 as follows:

A urethane acrylate oligomer [was] is obtained in the same manner as in Example 1 except that instead of 100 parts of polyol A, 50 parts (0.025 mol) of polyoxetetramethylene glycol having a molecular weight of 2,000, [was] is used, to obtain a urethane acrylate oligomer.

Page 15, please replace the paragraph beginning at line 27 as follows:

Examples 1 to 6 [were] may be evaluated by the following methods. The results possible are shown in Table 2.

Page 16, please replace the paragraph beginning at line 3 as follows:

The viscosity (cP) at 25°C [was] is measured by means of an E-type rotary viscometer.

Page 16, please replace the paragraph beginning at line 7 as follows:

To 100 parts of the urethane acrylate oligomer in each of Examples 1 to 6, 3 parts of benzophenone and 1 part of 2-hydroxy-2-methyl-1-phenylpropan-1-one [were] is added and thoroughly is mixed at 60°C, to obtain a photo-curable composition. The obtained photo-curable composition [was] is coated on an OPP film (Oriented polypropylene film) bonded to a glass plate by means of an applicator of 8 mil and is irradiated for 5 seconds by a high pressure mercury lamp having an output of 80 W/cm from a height of 15 cm, to obtain a cured film.

Page 16, please replace the paragraph beginning at line 17 as follows:

The surface tackiness of the cured film [was] is evaluated by touching with a finger.

Evaluation of the surface tackiness [was] is made based on the following standards. ◎: No tackiness, ○: no substantial tackiness, Δ: slight tackiness, and ×: substantial tackiness.

Page 16, please replace the paragraph beginning at line 23 as follows:

Further, the mechanical properties of the film i.e. the tensile strength (unit: kg/cm²) and the break elongation (unit: %), [were] is measured in accordance with JIS K6301.

IN THE CLAIMS

--1. (Amended) A urethane (meth)acrylate oligomer [obtainable] obtained by reacting a polyol component (A) consisting of [comprising] a [polyoxyalkylene] polyoxypropylene polyol which has from 2 to 4 hydroxyl groups, a hydroxyl value V_{OH}

(mgKOH/g) of from 5 to 115 and a total degree of unsaturation V_{US} (meq/g) satisfying the formula 1, with a polyisocyanate compound (B) and a hydroxylated (meth)acrylate compound (C):

$$V_{US} \leq (0.45/V_{OH}) + 0.02 \quad \text{Formula 1}$$

2. (Amended) The oligomer according to Claim 1, wherein the [polyoxyalkylene] polyoxypropylene polyol is a [polyoxyalkylene] polyoxypropylene polyol [obtainable] obtained by reacting an [alkylene] propylene oxide to an initiator by means of a double metal cyanide complex as a catalyst.

3. (Amended) A process for producing a urethane (meth)acrylate oligomer, which comprises reacting a polyol component (A) consisting of [comprising] a [polyoxyalkylene] polyoxypropylene polyol which has from 2 to 4 hydroxyl groups, a hydroxyl value V_{OH} (mg/KOH/g) of from 5 to 115 and a total degree of unsaturation V_{US} (meq/g) satisfying the formula 1, with a polyisocyanate compound (B) and hydroxylated (meth)acrylate compound (C) [as the sole unsaturated compound]:

$$V_{US} \leq (0.45/V_{OH}) + 0.02 \quad \text{Formula 1}$$

12. (Amended) [The] A cured urethane (meth)acrylate oligomer according to Claim 1, having a tensile strength of from 43 to 74 kg/cm².

13. (Amended) [The] A cured (meth)acrylate oligomer according to Claim 1, having a break elongation of from 320 to 560%.

14-15. (New).--